Manipulating spin polarization of titanium dioxide for efficient photocatalysis

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Abstract

Photocatalysis has been regarded as a promising strategy for hydrogen production and high-value-added chemicals synthesis, in which the activity of photocatalyst depends significantly on their electronic structures, however the effect of electron spin polarization has been rarely considered. Here we report a controllable method to manipulate its electron spin polarization by tuning the concentration of Ti vacancies. The characterizations confirm the emergence of spatial spin polarization among Ti-defected TiO2, which promotes the efficiency of charge separation and surface reaction via the parallel alignment of electron spin orientation. Specifically, Ti0.936O2, possessing intensive spin polarization, performs 20-fold increased photocatalytic hydrogen evolution and 8-fold increased phenol photodegradation rates, compared with stoichiometric TiO2. Notably, we further observed the positive effect of external magnetic fields on photocatalytic activity of spin-polarized TiO2, attributed to the enhanced electron-spin parallel alignment. This work may create the opportunity for tailoring the spin-dependent electronic structures in metal oxides. Photocatalyst activity depends significantly on the material’s electronic structures. Here, authors manipulate the electron spin polarization of TiO2 by tuning the concentration of Ti vacancies and show improved photocatalytic activities.